MILITARY CONSTRUCTION PLANNING AND DESIGN FUNDING REQUIREMENTS

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The Corps of Engineers can better identify its need for military construction planning and design (P&D) funds through the use of a model that incorporates the relationship of project size, design execution rates, and customer fund source. The costs of providing P&D services are not out of line with similar services provided in the private sector; however, cost reduction improvements can be made. The Corps should undertake a comprehensive review of design breakage, lost design, the differences between design costs for small and large projects, and the strategy for managing P&D.

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Executive Summary

MILITARY CONSTRUCTION PLANNING AND DESIGN FUNDING REQUIREMENTS

One of the U.S. Army Corps of Engineers (USACE) responsibilities is to design and construct military facilities for the Army, the Air Force, and other Department of Defense organizations. That design and construction program costs more than $2 billion each year and is funded as part of the military construction (MILCON) appropriation. Planning and design (P&D) funds are included in the planning subaccount of MILCON. Recently, the Corps conducted an internal review of the design and construction program to determine the cause of recent design fund shortfalls.

As part of that review, we found that the Corps' historic P&D costs were comparable to those typically found in the private sector for similar design services. However, we also found that the Corps' current method of forecasting future P&D requirements does not account for several key variables. This deficiency results in an insufficient amount of P&D funds being provided.

The project type, size, and typical design execution rate are major determinants of P&D funding requirements. We believe that the current formula, which is applied to all types of projects and provides 4 percent of the construction program amount for preliminary design 2 years prior to construction and 3.5 percent of the program amount for final design the year before construction begins, does not adequately account for those variables. Consequently, as the type and size of projects in the military construction program change, the current formula becomes less valid and results in funding levels that are inappropriate for the design program.

We have developed a microcomputer-based model for determining P&D funding requirements; it incorporates project type, size, and design execution rate into its forecasting algorithms. We recommend that the Corps use this model. Furthermore, to reduce P&D costs, we recommend that the Corps institute controls of design breakage and lost design, investigate design cost differences between large and small

projects, and develop a strategy for managing P&D efforts. We believe these actions are necessary for USACE to be responsive to budgetary pressures and to remain a competitive source for the design of military construction projects.

CONTENTS

CONTENTS (Continued)

TABLES

CHAPTER 1

EFFECTIVE MANAGEMENT OF THE PLANNING AND DESIGN PROGRAM

INTRODUCTION AND BACKGROUND

Services required for the planning and design of military construction programs and projects are funded from a subaccount of the military construction (MILCON) appropriation titled the Planning Account, which is more commonly referred to as the planning and design (P&D) account. Funds in this account are used to pay for services provided by both Government in-house engineering and design personnel and by private architectural and engineering (A-E) firms under contract with the U.S. Army Corps of Engineers (USACE). Virtually all of the Army's Military Construction program and, on average, 80 percent of the U.S. Air Force Military Construction program are accomplished by USACE. The Naval Facilities Engineering Command (NAVFAC) performs most of the Navy and Marine Corps military construction and about 10 percent of the Air Force military construction.

Funds averaging over $200 million per year have been required since 1985 to execute planning and design of the USACE MILCON programs. The P&D account represents a major portion of the USACE annual program. Moreover, this account helps to maintain the core of expertise in facilities engineering and design required for Armed Forces readiness.

THE PLANNING AND DESIGN ACCOUNT

The P&D account pays for most of the design and engineering services required before awarding a construction contract, after a project has been authorized for design. Certain engineering and design services required after contract award are also funded from the P&D account. Project design may require services like soil borings and topographic surveys which are appropriately funded from the P&D account. The customer installation and its major command are required to fund all planning done before design authorization. Master planning, alternative site

planning, and development of project requirements are typically funded from Operation and Maintenance, Army (OMA) or other installation funds.

Planning and Design Components and Concepts

The design phase of Army military construction projects accounts for about two-thirds of P&D funds. The primary components of the P&D account and their shares of the program for FY90 are:

- Military Construction, Army (MCA) Design – 67.2 percent
- Unspecified Minor Military Construction, Army (UMMCA) – 1.2 percent
- Standards and Criteria – 8.1 percent
- Value Engineering (VE) – 2.0 percent
- Host Nation Support (HNS), Far East and Europe – 21.5 percent.

The following summarizes the function of each account, other than MCA:

- Extremely limited UMMCA construction project funds are reserved for unforeseen priority projects that cost less than $1 million. These projects must provide usable and complete facilities and may precede or follow a MILCON project for a new mission requirement.
- Constant updating of standards and criteria ensures that USACE will use the latest technology in its design programs. The Corps also develops manuals, instructions, and standard designs using this funding element. Although this program can expand or contract to stay within available funds, USACE has tried to maintain at least a minimum effort to ensure criteria and standards remain current.
- By making independent review of designs at the preliminary stage, the VE program has avoided significant construction costs. Eliminating superfluous design features, identifying errors, and finding lower cost solutions have also reduced life cycle costs. VE studies maybe required for all projects that exceed the $2 million program amount (PA). Value Engineering studies made during the construction phase are funded by construction dollars rather than P&D dollars.
- The HNS account develops design criteria and provides surveillance of design and construction for military construction programs funded by host governments. Construction in the Far East consumes most of these funds, supporting a major annual construction program for Defense installations in Japan. The Far East HNS program requires approximately 3 percent of the total construction PA. The program in Japan is difficult to plan for, because

the Japanese Diet decides on specific projects in the Spring. After the legislative decision has been made, construction must proceed immediately, so the HNS funds must be available simultaneously. Sufficient funds for supporting Japanese projects must be available within the HNS program to ensure the host nation investment is not jeopardized.

Statutory Limitations and Constraints

A statutory limit of 6 percent for A-E services related to public works or utility projects was imposed by the Armed Services Procurement Act of 1947 (10 U.S.C. 4540). The A-E services subject to this limitation are defined as the preparation of "designs, plans, drawings, and specifications." Services not limited by this ceiling, but necessary for the preparation of a design include boundary, topographic, rights of way, utility easement surveys, subsurface explorations, cost estimates, and travel costs. If a project is designed solely by in-house forces, the 6 percent limitation does not apply. Since additional services are required for each construction project, the total P&D funds required will nearly always exceed 6 percent.

Although the P&D account is used to fund design-related functions, 10 U.S.C. 2807 prohibits use of P&D funds to develop project requirements. P&D funds may not be used for development of master plans; alternative site studies; development and validation of MILCON documentation before starting design; environmental assessments and impact statements; and studies and analyses to develop technical design parameters.

Design services, including plans, specifications, and related costs required for modifications to construction contracts, are funded from the P&D account. Design services related to two-step formal, advertised construction contracts and one-step competitive, negotiated (turn key) contracts are funded as direct construction costs. New family housing construction projects are typically acquired using the turn key method. Engineering and design services such as detailed construction layouts, as-built drawings, surveys for record purposes, and pavement evaluations required by the construction contractor in order to fulfill the contract are funded as part of the construction contract.

THE FUNDING AND EXECUTION PROCESS

The Services program and budget separately for their P&D requirements based on the expected size of future year MILCON programs. Major commands and their installations determine their construction requirements based on needs to modernize or replace aging facilities and to support new missions. Through the DoD's Planning, Programming, and Budgeting System (PPBS),[1] individual projects are prioritized, spread over a 5-year period, and identified in the Five Year Defense Program (FYDP).[2] After the annual programming process, the first year of the FYDP becomes the basis for the President's annual budget proposal to Congress.

The President's budget, therefore, requests P&D funds based on future year MILCON programs. For example, the FY90 budget requested funds for preliminary design of the FY92 MILCON program and final design of the FY91 MILCON program. In recent years, DoD has determined the size of the P&D requirement to be 7.5 percent of the total construction PA. The P&D fund level for FY90, for example, was determined by applying 4 percent against the FY92 MILCON PA and the remaining 3.5 percent against the FY91 PA. The first year increment provides for design to reach the 35 percent preliminary or concept stage at which time fairly accurate cost estimates for the construction project can be determined. These costs are then presented to congressional committees in order to make a final determination whether to authorize and appropriate funds for each individual construction project. If a project is included in the authorization bill, then the additional 3.5 percent P&D funds are included in the following year appropriation request to complete final design of the project.

After enactment of the annual MILCON appropriation, the Services then request the design and construction agents, USACE or NAVFAC, to initiate design services for their specific projects. USACE issues a Code 1 directive which authorizes the district, through its parent division, to proceed with preliminary actions, or a Code 2 which authorizes concept design to the 35 percent stage. Under unusual circumstances the district may receive a Code 6 directive immediately which authorizes proceeding with both concept and final plans and designs. USACE issues

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[1]An alternative acronym for PPBS is PPBES. The "E" is included to represent Execution of programs after funds have been received.

[2]Since adopting biannual budgeting within DoD, a sixth year has been added to the FYDP. The acronym SYDP is sometimes used rather than FYDP.

P&D funds quarterly to the districts via their parent divisions for in-house P&D direct labor and support. P&D funds for A-E projects are provided individually to each district after successful negotiation of each A-E contract. At most districts, the project manager, typically assigned within the Engineering Division, is the district agent responsible for the oversight of P&D funds for MILCON projects. Flexibility exists at the district level to shift funds between projects as necessary. P&D limits are not specified by project in the MILCON appropriation.

Architect-Engineer Design

Approximately 80 percent of the engineering and design work assigned to the Corps of Engineers is accomplished by private sector A-E firms. During the 5-year period 1985 through 1989, it is estimated that military construction design workload valued at nearly $1 billion was placed with these firms. The firms often possess more extensive technical capabilities and staffing levels than can be maintained within USACE staffing limitations. The nature of work assigned to A-E firms varies widely and includes, for example, design of complex medical, research, and production facilities, airfield installations, and making geotechnical studies and cost estimates.

Public Law 92-582, popularly known as the "Brooks Bill," requires that A-E contractors be selected on the basis of demonstrated competence and qualifications. Lawmakers determined that the public interest would be best served by selections based on the quality of the contractor rather than the usual procurement criterion of lowest price. Contracting officers must, nevertheless, adhere to all negotiated contract principles spelled out by the Federal Acquisition Regulations (FAR) to ensure that the final contract price is fair and reasonable.

Selection procedures require that each contract for A-E services be announced in the *Commerce Business Daily* for 30 days. A-E firms interested in submitting a proposal for a specific project must submit their special qualifications which are screened by a pre-selection board at each district office. Those firms best qualified are screened by a separate district selection board which identifies at least the top three in preferred order. Once approved, the top firm is requested to develop and submit a proposal for the work. The Government must then prepare an independent estimate which forms the basis for negotiations. If negotiations are successful, contract documents are finalized, the contract is awarded, and the contractor is notified to proceed. If the Government is unable to reach agreement with the number

one firm, the contracting officer must terminate negotiations and initiate the same process with the second most qualified firm, etc. The entire selection and award process averages 8 to 9 months requiring substantial P&D funds just to award a contract to an A-E firm.

When the contract for engineering and design services has been signed, the A-E firm prepares a concept design consisting of alternative schematic layouts, material descriptions, and preliminary cost estimates. After satisfying the user (usually an installation or a major command), the A-E firm refines the concept design which provides the basis for the Service MILCON program budgets that must be presented to Congress. The final design phase is usually set aside as an option within the A-E contract so the Government can stop the project at the concept design stage if Congress or other higher authority decides to cancel or defer the project. After completing the final plans and specifications, the A-E firm remains available for consultation during the construction phase and sometimes is hired for on-site inspection and quality assurance.

In-house Design

The Corps of Engineers has established a target to design 25 percent of its military construction programs using in-house forces. In-house work keeps the Government A-E design skills current. It also enables the in-house team to better review work accomplished by contractors. The Corps can also be more responsive to urgent customer projects that do not allow the time required to hire an A-E firm. As funds are reduced during periods of downturns in the construction program, district offices need to be able to shift a greater portion of the work to in-house forces to retain their in-house capability. The Chief of the Engineering Division usually determines which customer projects will be accomplished by the Government designers and which will be contracted out to A-E firms, based on staff available and other factors.

AVAILABILITY OF PLANNING AND DESIGN FUNDS

The fact that the USACE need for P&D funds has exceeded their availability in FY89 and FY90 leads to the questions of why this happened and what should be done about it. In FY90, for example, the shortfall was estimated to be approximately $10 million. We have described the uncertainties associated with the P&D funding account. Estimating the requirement for design funds for programs that might be constructed 2 years in the future cannot be an exact process. In the recent past, it was

not necessary to make exact forecasts because of MILCON program growth that began during the mid 1980s. USACE met current year design requirements by using P&D funds allocated for future programs. But when the out-year construction programs began to disappear, there was a sharp decline in the P&D funds available. The funds to complete current design programs and to initiate preliminary designs for future programs had been used already.

Faced with present demands for realistic estimates, the methodology for estimating the P&D funds required for engineering and design requires thorough review. A system must be devised that allows projects to be added to or deleted from the program with minimum turbulence or uncertainty.

The remainder of this report examines the factors that affect P&D estimating as well as the policies and practices that govern the P&D program. Chapter 2 examines design costs for programs managed by the Corps. It also examines similar data from the other Services. In Chapter 3, private-sector design costs are compared to similar data from the Corps. The conclusions of these reviews and analyses are presented in Chapter 4, followed by Logistics Management Institute recommendations in Chapter 5. Detailed analyses and data summaries are presented in Appendices A through D.

CHAPTER 2

ANALYSIS OF USACE PLANNING AND DESIGN COSTS

DESCRIPTION OF DATA

Our analysis of USACE P&D costs was performed using data obtained from USACE's Automated Management and Progress Reporting System (AMPRS), as reported to USACE's Military and Civil Progress Reporting System. We started with an initial file containing selected data elements for all 23,678 military construction projects in the AMPRS database at the end of 1989.

To maximize the reliability and relevance of our data, we restricted our analysis to 10,175 projects from program years (PY) 1985 through 1989 for which construction contract awards had been authorized. We then eliminated those projects without P&D costs, projects with invalid dates, projects with no construction contract and/or program amounts, and duplicate records. This left 5,222 projects which were the basis for our analysis. Table 2-1 shows the database used for analysis by division, and Table 2-2 shows the database mix by customer/fund type.

We believe that the analysis database accurately represents the total USACE military program. The 5,222 projects total over $9.9 billion in construction contracts and about $800 million in P&D costs.

DEFINITIONS AND CALCULATIONS

Since many projects spanned several fiscal years, and since the database spanned multiple program years, we had to account for the effects of inflation. We therefore converted all costs to constant 1991 dollars, using the DoD Total Obligation Authority (TOA) Deflator for Military Construction as our index. For this purpose, we assumed that construction contracts were awarded on the design completion date and that P&D costs occurred halfway between the design start and design completion dates.

We then calculated P&D cost ratios, defined as total inflation-adjusted planning and design expenditures (including A-E contracts plus supervision and review),

TABLE 2-1

DISTRIBUTION OF PROJECTS BY REPORTING DIVISION

Reporting division	Number of projects: initial file	Percent of projects: initial file	Analysis projects: number	Analysis projects: percent
European	3,660	15.5	240	4.6
Huntsville	35	0.1	0	0.0
Missouri River	2,694	11.4	427	8.2
North Atlantic	2,808	11.8	555	10.6
North Central	3	0.1	0	0.0
New England	105	0.4	18	0.3
North Pacific	1,160	4.9	373	7.2
Ohio River	1,318	5.6	386	7.4
Pacific Ocean	5,236	22.1	1,780	34.1
South Atlantic	2,738	11.6	685	13.1
South Pacific	2,159	9.1	325	6.2
Southwestern	1,762	7.4	433	8.3
Total USACE	23,678	100.0	5,222	100.0

divided by total inflation-adjusted construction contract amounts (including any recorded modifications), for each relevant project category. We used the construction contract amount – rather than the program amount – as our denominator because it more accurately reflected true project costs and because this data element was better maintained in AMPRS.

PLANNING AND DESIGN COST RATIOS: PY85 THROUGH PY89

After adjusting for inflation, the average P&D cost for all 5,222 projects was $187,448, while the average construction contract amount was $2,269,679. This translates into an overall P&D ratio of 8.3 percent for all military programs. In other words, for every $1,000 of construction contract awards associated with PY85 through PY89 military projects, USACE spent about $83 on P&D. If one assumes that construction contract amounts equal 89 percent of program amounts, this means that USACE P&D costs have averaged 7.4 percent of program amounts

TABLE 2-2

DISTRIBUTION OF PROJECTS BY CUSTOMER/FUND TYPE

Customer/fund type	Number of projects: initial file	Percent of projects: initial file	Analysis projects: number	Analysis projects: percent
Military Construction, Army	3,729	15.8	842	16.1
Military Construction, Army Reserve	251	1.1	94	1.8
Military Construction, Air Force	3,699	15.6	1,062	20.3
Military Construction, Other	3,041	12.9	555	10.6
Operations and Maintenance, Army	6,072	25.6	1,500	28.7
Operations and Maintenance, Air Force	1,623	6.9	344	6.6
Family Housing, Army	1,474	6.2	588	11.3
Family Housing, Air Force	127	0.5	16	0.3
Production Base Support	715	3.0	171	3.3
Foreign Military Sales	528	2.2	27	0.5
Host Nation Support	879	3.7	4	0.1
Defense Environmental Restoration Program	804	3.4	19	0.4
Engineering not related to construction	736	3.1	0	0.0
Total USACE	23,678	100.0	5,222	100.0

(8.3 times 0.89). However, as noted below, there has been a significant variation over time, so that recent projects have cost substantially more than 7.4 percent.

Variations by Project Type

This overall P&D ratio masks considerable variation within the analysis database. One key variable is project type; Table 2-3 shows that P&D ratios ranged from under 4 percent for family housing projects to over 10 percent for certain military construction projects. These variations reflect differences in the nature and complexity of projects, differences in the planning and design process, the role of foreign governments, and other factors.

TABLE 2-3

USACE PLANNING AND DESIGN (P&D) RATIOS

Project category	Number of projects	P&D ratio percent
Project type		
Military Construction, Army	842	8.3
Military Construction, Army Reserve	94	8.8
Military Construction, Air Force	1,062	10.1
Military Construction, Other	555	7.2
Operations and Maintenance, Army	1,500	9.2
Operations and Maintenance, Air Force	344	6.4
Family Housing, Army	588	3.5
Family Housing, Air Force	16	3.5
Production Base Support	171	8.0
Foreign Military Sales	27	6.0
Host Nation Support	4	4.2
Defense Environmental Restoration Program	19	4.0
Project size (construction contract)		
Under $1 million	3,037	14.9
$1 million – $5 million	1,555	10.0
$5 million – $10 million	388	7.5
Over $10 million	242	6.0
Design agent		
A-E firm	3,617	8.5
In-house	1,605	7.4
Program year		
1985	819	7.3
1986	1,131	8.1
1987	1,413	8.0
1988	1,093	8.9
1989	766	10.0
Total (all projects)	5,222	8.3

Note: P&D ratio equals planning and design cost as a percentage of construction contract amount.

Variations by Project Size

Another key characteristic is project size. The existence of a size effect was not surprising; fixed costs make smaller projects more expensive to design, while economies of scale make larger projects less expensive to design. However, the magnitude of this effect was remarkable. Table 2-3 shows that the total P&D ratio was 15 percent for construction contracts under $1 million, but only 6 percent for construction contracts over $10 million.

Variations by Design Agent

Table 2-3 shows that P&D ratios were higher for projects designed by A-E firms than for projects designed in-house. The higher P&D costs for A-E projects include profits charged by the private sector along with internal (USACE) contract supervision and review costs. There also may be some bias when selecting which projects are to be awarded to A-E firms. However, increasing the proportion of work to be designed in-house would not necessarily reduce the overall P&D ratio, since USACE personnel currently working on A-E projects may not be as productive as outside firms in such a capacity. A shift to more in-house work might limit USACE's ability to respond to future workload changes by hiring outside firms.

Variations by Program Year

The P&D ratio of 8.3 percent for the entire analysis database also masks considerable variation by program year. Table 2-3 shows that the overall P&D ratio has grown steadily over the 5-year analysis period. The ratios for both PY88 and PY89, when translated into program amount terms, both exceeded the 7.5 percent ratio used by DoD for budgeting purposes, which may have created a significant shortfall of P&D funds for those 2 years.

REASONS FOR INCREASES OVER TIME

Changes in Program Mix

The overall P&D ratio is an average of project-category-specific component ratios, weighted by the proportions of projects in each such category. Changes in the program mix can therefore affect the overall P&D ratio even if the component ratios themselves remain the same. Decreasing project sizes, along with other program mix changes, explain almost half of the growth in P&D ratios over time.

The biggest single influence has been a shift to smaller projects during the analysis period. The average inflation-adjusted construction contract amount fell from $3.6 million in PY85 to $1.9 million in PY89. Table 2-4 shows how this shift accounted for a 1.0 percent increase – from 7.3 percent to 8.3 percent – in the overall P&D ratio from PY85 through PY89 (holding size-specific P&D ratios at PY85 levels).

A second factor is that the distribution of projects by type also changed from PY85 through PY89. Table 2-4 shows that this mix shifted toward Military Construction, Air Force and Family Housing, Army projects; and away from Military Construction, Army and Military Construction, Other. This shift was not uniform over time, however, and only accounted for a 0.2 percent increase – from 7.3 percent to 7.5 percent – in the overall P&D ratio from PY85 through PY89 (holding type-specific P&D ratios at PY85 levels).

The other key project characteristic included in our analysis was design agent (in-house versus A-E firm). Although Table 2-4 shows an increase since PY85 in the proportion of in-house projects, this shift did not have a significant effect on the overall P&D ratio. The difference between A-E and in-house P&D ratios in PY85, and the shift in the design agent mix from PY85 through PY89, were both fairly small.

Role of Other Factors

A third cause of growing P&D ratios was differing rates of inflation. From 1985 through 1989, private-sector civil engineer salaries rose by 16.8 percent[1] while the building construction index rose by 9.8 percent.[2] Using the former as a proxy for P&D costs (since P&D is highly labor-intensive and since most USACE projects are designed by A-E firms), and using the latter as a proxy for construction contract amounts, the overall P&D ratio would have risen by 0.5 percent over this period from 7.3 percent to 7.8 percent (= 7.3 x 1.168/1.098) – even without any changes in the program mix.

A fourth factor is lost design: P&D expenditures that have been superseded by changes in project scope or definition. We used a second AMPRS download with the

[1] U.S. Department of Labor, Bureau of Labor Statistics, Division of Labor Force Statistics.

[2] "ENR Indexes Track Costs Over the Years." *Engineering News Record.* 23 March 1989: p. 52.

TABLE 2-4

EFFECTS OF CHANGES IN PROJECT MIX FROM PY85 THROUGH PY89

Project category	(1) PY85 P&D ratio (%)	(2) PY85 project mix (%)	(3) = (1) & (2) PY85 ratio weighted by PY85 mix (%)	(4) PY89 project mix (%)	(5) = (1) & (4) PY85 ratio weighted by PY89 mix (%)
Construction contract size					
Under $1 million	17.1	4.3	0.74	9.6	1.64
$1 million – $5 million	9.5	25.9	2.46	36.0	3.42
$5 million – $10 million	6.7	24.1	1.61	21.5	1.44
Over $10 million	5.5	45.7	2.51	32.9	1.81
USACE total	N/A	100.0	7.32	100.0	8.31
Project type					
Military Construction, Army	7.0	38.8	2.72	31.5	2.21
Military Construction, Army Reserve	9.2	1.3	0.12	3.2	0.29
Military Construction, Air Force	9.0	31.9	2.87	36.8	3.31
Military Construction, Other	5.7	14.0	0.80	8.6	0.49
Operations and Maintenance, Army	8.1	4.0	0.32	6.0	0.49
Operations and Maintenance, Air Force	3.4	1.4	0.05	0.9	0.03
Family Housing, Army	3.8	4.5	0.17	8.1	0.31
Family Housing, Air Force	2.6	0.5	0.01	0.2	0.01
Production Base Support	7.4	2.5	0.19	3.8	0.28
Foreign Military Sales	4.2	0.5	0.02	0.1	0.00
Host Nation Support	N/A	0.0	0.00	0.0	0.00
Defense Environmental Restoration Program	7.6	0.5	0.04	0.7	0.05
USACE total	N/A	100.0	7.31	100.0	7.47
Design agent					
Designed by A-E firm	7.4	83.6	6.18	76.3	5.65
Designed in-house	7.0	16.4	1.15	23.7	1.66
USACE total	N/A	100.0	7.33	100.0	7.31

Notes: N/A = not applicable; percentages in Columns (2) and (4) are based on construction contract amounts and may not add to exactly 100.0 due to rounding.

same program year and authorization phase criteria to estimate these costs. We found that lost design (as a proportion of construction contract amount) was

0.3 percent higher for PY89 projects than for PY85 projects, with most of the increase occurring between PY88 and PY89.

This implies that lost design costs added 0.3 percent to the overall P&D ratio from PY85 through PY89. Although USACE experts believe that lost design is underreported in AMPRS, there is no reason to suspect that the degree of under-reporting has changed over time, and a review of other data sources suggests that this increase is the correct order of magnitude.

Finally, there are several other factors which may have contributed to the growth in P&D costs over time, but their effects cannot be readily quantified. Such factors include new regulatory requirements, increased program turbulence, inefficient staffing levels, and/or the costs of computer-aided design (savings from which tend to be realized in the construction or operation of a facility rather than in the cost of its design).

TIMING ISSUES

The rates at which USACE military projects incur P&D costs are also important, because two projects with equal P&D costs may need different amounts of P&D funds per fiscal year. The proportion of a project's P&D costs incurred in a given fiscal year depends upon the length of the P&D period for that project, and Table 2-5 shows that project durations varied widely by customer/fund type. Military Construction projects (particularly Army Reserve) tended to last the longest, while Operations and Maintenance projects (along with several smaller categories) tended to be the shortest. Even within a single customer/fund type, project durations ranged from under 6 months to over 24 months.

The proportion of a project's P&D costs incurred in a given fiscal year also depends upon the month in which that project starts, and Table 2-6 shows that P&D start dates are not evenly distributed throughout the year. Fewer projects begin in the first quarter of a fiscal year (October through December), while there tends to be a year-end surge in September. The distribution of starting dates also varies by customer/fund type.

Finally, the proportion of a project's P&D costs incurred in a given fiscal year depends upon the relationship between time expended and costs incurred. We were unable to estimate this relationship for the sample projects because of data

TABLE 2-5

DISTRIBUTION OF PROJECTS BY DURATION OF PLANNING AND DESIGN PHASE

Project type	1 – 6 months (%)	7 – 12 months (%)	13 – 18 months (%)	19 – 24 months (%)	Over 24 months (%)	Total (%)
Military Construction, Army	6.9	11.5	28.7	23.7	29.3	100.0
Military Construction, Army Reserve	0.0	3.3	13.0	27.2	56.5	100.0
Military Construction, Air Force	2.7	13.4	29.6	26.3	28.1	100.0
Military Construction, Other	26.2	25.9	20.6	13.4	13.9	100.0
Operations and Maintenance, Army	49.1	30.0	11.5	4.2	5.3	100.0
Operations and Maintenance, Air Force	49.6	35.3	10.5	2.0	2.6	100.0
Family Housing, Army and Air Force	37.6	30.1	16.2	9.2	6.9	100.0
Production Base Support	4.7	21.9	32.0	20.1	21.3	100.0
Foreign Military Sales, Host Nation Support, and Defense Environmental Restoration Program	70.8	18.8	6.3	2.1	2.1	100.0
Total	26.9	22.7	20.1	14.2	16.1	100.0

Note: Certain project categories were combined because of small sample sizes.

limitations, so we relied upon factors previously developed by LMI.[3] Table 2-7 displays those factors for both in-house and A-E projects, using work completed as a proxy for costs incurred. P&D Costs are not incurred evenly throughout a project; there are surges of work at the beginning and end and relatively slow periods in the middle. Work also tends to be completed more rapidly for A-E projects than for in-house projects.

The effects of these three variables were combined into spreading factors, which are displayed in Table 2-8. These factors equal the proportions of total P&D costs for a project required in each fiscal year surrounding the PY, and vary greatly by customer/fund type. For example, family housing projects require over 70 percent of

[3]LMI Report AR603R1. *Corps of Engineers Resource and Military Manpower System*. Moore, William B. and Robert W. Salthouse, Robert A. Hutchinson, and Robert L. Crosslin, May 1987.

TABLE 2-6

DISTRIBUTION OF PROJECTS BY MONTH THAT PLANNING AND DESIGN STARTED

Project type	January – March (%)	April – June (%)	July – September (%)	October – December (%)	Total (%)
Military Construction, Army	17.3	37.4	32.2	13.1	100.0
Military Construction, Army Reserve	23.4	13.8	33.0	29.8	100.0
Military Construction, Air Force	20.1	34.2	29.3	16.4	100.0
Military Construction, Other	28.5	26.7	25.0	19.8	100.0
Operations and Maintenance, Army	31.1	28.0	25.7	15.2	100.0
Operations and Maintenance, Air Force	25.9	20.6	32.6	20.9	100.0
Family Housing, Army and Air Force	27.3	25.0	29.3	18.4	100.0
Production Base Support	36.3	22.2	15.8	25.7	100.0
Foreign Military Sales, Host Nation Support, and Defense Environmental Restoration Program	18.0	26.0	30.0	26.0	100.0
Total	25.5	29.3	28.1	17.1	100.0

Note: Certain project categories were combined because of small sample sizes

their total P&D funds 2 years in advance of the PY, while operations and maintenance projects do not require any P&D funding before the PY.

Appendix A contains detailed displays of the data supporting the analyses discussed in this chapter. The data are displayed by customer/fund type, program year, construction contract amount, and design agent (in-house or A-E) and cover the period PY85 through PY89. Similar data for the period 1987 through 1989 are also displayed, because they were the basis for developing factors used to formulate a revised methodology to estimate P&D funding requirements.

Appendix B presents a comparison of P&D costs for Army and Air Force projects. Of major significance is the finding that effect of project size explains much of the difference in Army and Air Force P&D ratios: a higher number of smaller Air Force construction projects leads to higher Air Force P&D ratios. Higher P&D

TABLE 2-7

DESIGN TIME EXPENDED COMPARED TO DESIGN WORK COMPLETED

Proportion of time expended (%)	Proportion of work completed	
	A-E projects (%)	In-house projects (%)
5.0	9.1	4.9
10.0	18.3	9.7
15.0	23.1	14.2
20.0	29.1	18.2
25.0	31.0	23.1
30.0	33.0	26.4
35.0	33.7	28.7
40.0	34.2	28.7
45.0	37.9	28.7
50.0	41.5	31.2
55.0	45.1	33.8
60.0	45.6	36.4
65.0	50.4	36.9
70.0	54.7	45.2
75.0	61.8	53.5
80.0	68.8	64.5
85.0	78.5	74.2
90.0	89.1	84.7
95.0	95.7	94.4
100.0	100.0	100.0

costs for Military Construction, Air Force projects are also linked to a higher level of management attention (reviews and design decision making) and special design requirements, including comprehensive interior designs.

TABLE 2-8

DISTRIBUTION OF PLANNING AND DESIGN COSTS IN RELATIONSHIP TO PROGRAM YEAR

Project type	Proportion of total P&D costs incurred				
	PY – 2 (%)	PY – 1 (%)	PY (%)	PY + 1 (%)	Total (%)
Military Construction, Army	31.2	40.0	21.8	7.0	100.0
Military Construction, Army Reserve	22.7	33.1	27.9	16.3	100.0
Military Construction, Air Force	34.0	42.7	18.9	4.4	100.0
Military Construction, Other	54.1	30.1	7.9	7.9	100.0
Operations and Maintenance, Army	0.0	0.0	76.9	23.1	100.0
Operations and Maintenance, Air Force	0.0	0.0	81.0	19.0	100.0
Family Housing, Army	77.2	20.7	1.8	0.3	100.0
Family Housing, Air Force	71.0	29.0	0.0	0.0	100.0
Production Base Support	43.0	41.9	12.4	2.7	100.0
Foreign Military Sales and Host Nation Support	80.3	19.1	0.6	0.0	100.0
Defense Environmental Restoration Program	N/A	N/A	N/A	N/A	N/A

Finally, Appendix C presents a brief analysis of Navy projects based on NAVFAC data that are comparable to AMPRS. We found a similar relationship between P&D costs and project size, and similar overall P&D cost ratios.

CHAPTER 3

COMPARISON OF USACE AND PRIVATE-SECTOR DESIGN COSTS

CLASSIFICATION OF COSTS

The key to establishing useful categories of planning and design costs is to group like projects together to create homogeneous categories. We created categories by grouping projects by type of work. For the MILCON program, the type of work can be described by fund type – the source of funds and customer. This categorizing is similar to defining the customer lines for a large engineering and construction organization, and we have adopted that terminology in this report. The list of customer categories is shown in Table 3-1.

TABLE 3-1

USACE CUSTOMER CATEGORIES

Military projects
Military Construction, Army
Military Construction, Army Reserve
Military Construction, Air Force
Military Construction, Other
Operations and Maintenance, Army
Operations and Maintenance, Air Force
Family Housing, Army
Family Housing, Air Force
Production Base Support

DATA SOURCES

USACE Data Sources

Cost data for USACE are maintained in the Corps of Engineers Management Information System (COEMIS). Although COEMIS is the database of record for all

financial information, some cost information in a more readily analyzed format is available in both the Automated Management and Progress Reporting System (AMPRS) and the Project Reporting Information System for Management (PRISM). Engineering costs for the MILCON program are maintained by individual project in the military module of COEMIS. Individual project costs in COEMIS are used to update AMPRS periodically. Our analysis of USACE data is based upon the 5,222 projects distilled from the AMPRS database, described in Chapter 2.

Private-Sector Data Sources

The raw data for private-sector design costs was obtained from the annual survey sponsored by *Professional Services Management Journal (PSMJ)*. The survey volume, titled *Design Services Fee Structure Survey*, contains detailed cost information by type of firm, type of project, and level of service. The databases summarized in this report were accumulated from their annual survey of over 260 firms each presenting information on as many as eight construction types. The information captured for each project type consisted of many of the design firms' individual design projects and comprised a significant portion of their total workload.

COST COMPARISONS

The amount and type of planning and design services provided on private-sector projects vary significantly from project to project because an owner may contract for a "full" set of services or may decide to purchase only selected services. Full-service USACE projects may differ from full-service private-sector projects because military organizational capabilities, statutes, and established policies frequently dictate where and how much work will be performed. Consequently, a differential between private-sector and USACE costs may only reflect differences in the services received and not relative efficiency of the design work.

Project costs must be normalized to reflect the provision of a commonly defined full set of services before making any comparisons. For engineering services, we used the full set of services defined by the American Institute of Architects (AIA) Document B141, *Standard Form of Agreement Between Owner and Architect*, and some additional services included in the *PSMJ* survey, such as predesign services and cost estimating. We found that, despite some minor differences in terminology, these definitions applied to both private-sector and USACE projects.

We normalized the design costs by first allocating the percentage of the total design cost to each P&D service and then adjusting the reported private-sector project costs for the services not provided. The full-service costs were then adjusted again to reflect services normally paid by supervision and administration (S&A) funds during USACE projects. The normalized private-sector costs were then aggregated by type of construction so they were consistent with the USACE customer categories in Table 3-1. The design costs can now be compared. A detailed discussion of the normalization process is presented in Appendix D. Appendix D also contains the list of fund types and work included in USACE customer categories as well as the mapping of private-sector projects to USACE customer categories.

MILCON Versus Private Sector

The full-service planning and design cost factors for the MILCON program are compared with private-sector cost factors in Table 3-2. The cost factors shown in this table are determined by dividing the cost of adjusted P&D costs by the total construction contract amount.

TABLE 3-2

MILITARY PLANNING AND DESIGN – CONSTRUCTION COST RATIO COMPARISON

Military projects	Private sector			USACE
	25th percentile	Mean (%)	75th percentile	Mean (%)
Military Construction, Army	6.0	8.2	8.9	8.0
Military Construction, Army Reserves	6.7	8.9	9.6	8.0
Military Construction, Air Force	6.0	8.2	8.9	9.4
Military Construction, Other	6.5	8.3	8.8	8.8
Operations and Maintenance, Army	8.2	8.8	10.9	9.0
Operations and Maintenance, Air Force	8.5	8.8	10.9	6.1
Family Housing, Army	7.7	9.3	11.0	3.4
Family Housing, Air Force	7.7	9.3	11.0	3.4
Production Base Support	8.5	8.8	10.9	7.9

The mean USACE cost factor for each customer is compared to the range of comparable private-sector projects. The 25th percentile is the point in the range

below which 25 percent of the projects cost less, while the 75th percentile is the point above which 25 percent of the projects cost more. Project costs vary significantly. We believe cost performance between the 25th and 75th percentiles should be considered reasonable, although not necessarily efficient. Most USACE cost factors do not exceed the private-sector 75th percentile while some categories are less than the mean and others even less than the 25th percentile.

The significant variance between the private-sector and USACE housing P&D cost factors (9.3 percent vs. 3.4 percent) exists because most USACE new construction housing projects are built using turnkey procedures that combine design and construction into a single bid package. The design portion is funded as part of the construction cost, thereby avoiding the use of P&D funds. The repetitive nature of housing designs in large housing projects also reduces the housing P&D cost.

CHAPTER 4

CONCLUSIONS

Analysis of recent data on USACE military construction projects provides sufficient information upon which to base our conclusions and recommendations. Our results were corroborated by reviews of similar construction data from the other Services and from the private sector.

THE CURRENT 7.5 PERCENT METHOD IS INAPPROPRIATE AND INADEQUATE

From FY85 through FY89, the practice of estimating 7.5 percent of total program amount for P&D has been approximately correct for the total funds required. In FY88 and FY89, however, this formula significantly understated the true requirement for P&D funds. Changes in the mix and complexity of programs, in project size, the spreading of design execution over time, and other factors all affect the requirement for P&D funds.

Program Complexity and Project Size

Variations in program content occur each year and generate different levels of P&D funding requirements. Each appropriation contains its own requirement for P&D funds, based upon the factors characteristic of projects comprising that account. Within each appropriation group, i.e., MILCON or OMA, individual projects will contain different P&D requirements affecting funding needs. Complex projects, such as medical or high-tech facilities, require more P&D effort than do runways or troop housing facilities. Investigating P&D requirements below the appropriation level or by facility category, however, is beyond the scope of this report.

Although project size is a prime contributor to the P&D requirement, P&D costs do not grow proportionally with total project size. A doubling of the P&D-to-construction cost ratio occurs when moving from projects over $10 million down to those less than $1 million. We believe this wide variance is caused in part because the same, expensive administrative and review procedures must be applied to each project, regardless of size. Additionally, the fixed amount of planning, site visits, design, estimating, and specification effort must be accomplished for any size

project. These fixed costs, when spread over a smaller construction base, will cause the P&D ratio to increase. We conclude, therefore, that to properly estimate the P&D funding requirement, the mix of appropriations and size of projects for any given construction program must be taken into account.

Spread of Design Requirements Over Time

The traditional 7.5 percent P&D requirement calculation assumes that 4 percent of the PA is needed 2 years before the year of construction (PY) to achieve the preliminary or concept design stage, and the remaining 3.5 percent is required 1 year before construction for final design. In fact, the real requirement for military construction P&D spreads over a 4-year period. Approximately 20 percent of the P&D funding is required in the PY to complete final designs, and a small residual of 5 percent is required in the following year for construction P&D support. The timing mismatch of funding availability versus funding requirement can cause difficulty managing P&D accounts, particularly during periods of changing program levels.

P&D Ratios Vary by Customer Within Each Appropriation

Consistency in the P&D ratios within each appropriation, which parallels customer P&D ratios, reflects consistency within each customer's management of its P&D account and the mix of projects within each construction program. Projects comprising the Air Force Military Construction program are different from those for Army Construction. For example, avionics overhaul facilities require more P&D work than vehicle storage facilities. In order to properly plan for P&D requirements, it is important to allow for the P&D variations inherent within each appropriation and customer category.

CONSTRUCTION PROGRAM INCREASES MASK DEFICIENT P&D FUNDING

The 7.5 percent formula allows funds to be allocated before they are actually needed. When this happens during a construction program increase, enough funds are received to pay for design requirements from the year before that are being executed in the current fiscal year. Although the P&D ratio may not be large enough to cover actual PY costs, receiving funds for designing future year programs will appear to offset such a shortage.

CONSTRUCTION PROGRAM DECLINES AMPLIFY DEFICIENT P&D FUNDING

As a construction program levels off or begins to decline, the 7.5 percent formula creates too little funding to meet program design commitments for the current year. During any 1 year, not only must the third and fourth years of earlier programs be completed, but the first and second years of new programs must also be designed. The 4 percent and 3.5 percent increments of the 7.5 percent formula begin to generate less P&D funding when multiplied against a decreasing construction base. Underfunding begins to proliferate. This situation has occurred for the P&D account for FY89 and FY90. If the MILCON program continues to decline as expected, P&D deficiencies will worsen.

FUNDS ALLOCATION PLANNING

Design execution occurs at varying rates within each fiscal year. MILCON P&D execution tends to be heavier in the third and fourth quarters of each fiscal year (April through September), which is important for funds allocation planning. Other appropriations (including operations and maintenance) spread more evenly, but the weighted average shows all funds have a low execution rate in the first quarter (October through December). If more execution could be pushed toward the first quarter, a better workload distribution could be achieved resulting in more efficient operations.

DESIGN BREAKAGE AND LOST DESIGN

Our conclusion that the formula for computing the P&D requirement is inadequate addresses only a portion of the P&D issue – that of obtaining the correct amount of P&D funding. There remains, however, the requirement to optimize use of funds available. One of the more significant improvements needed in the management of P&D is to improve the areas of design breakage and lost design. Design breakage occurs when P&D funds have already been used for design and then the project is canceled or not expected to be advertised for construction. Lost design is created when additional funds are required because of changes in scope, sites, criteria, or funding after projects have begun.

USACE cannot always control design breakage. Major commands struggling to keep their construction programs within tight fiscal constraints may be required to defer or cancel a project for which preliminary design has been started. Annual budget reviews and congressional actions can often cause design breakage. Arguably, design breakage can be viewed as enriching the P&D account, because the design funds have already been obtained in an earlier year and that portion not expended can be applied for other needs within the account. We believe that any projects added late to the program, such as those inserted during congressional review, absorb any such available funds.

There have been initiatives within the Services to minimize the amount of lost design through control of user changes. The Air Force requires that its major commands manage their own shares of the P&D account and, therefore, places control in the hands of the user. In theory, the user will support only the most important changes after design has begun. Additionally, the installation or major command should do a better job of planning the project before it is submitted in the budget. The FY90 contract award moratorium imposed by the Secretary of Defense has put the Air Force plan on hold, so its effectiveness cannot yet be assessed.

Because lost design is very difficult to measure, it becomes difficult to report. The magnitude of lost design depends upon estimates which are actually not credible. Nevertheless, Congress has placed special emphasis on lost design, quite plausibly suspecting that lost design reduces the effectiveness of the planning and design program. Such an assessment is beyond the scope of this report, although clearly a reduction in lost design would reduce P&D funding deficiencies.

OTHER P&D COMPONENTS

P&D funds for HNS and for Standards and Criteria need to be justified separately from the funds required for MILCON project design. Similarly, execution of those funds needs to be managed separately to ensure control and effectiveness of each component. Permitting funds earmarked for project design to be siphoned off for other requirements leads to distortion of the account and demoralizes those who are trying to manage within their funding control targets. We were not able to estimate the magnitude of this funds mixing practice, but a number of officials expressed concern that controls over P&D fund allocations are inadequate.

The merits of funding VE as a separate component of the P&D account need to be examined further. The argument that because the VE account is a cost saver, it should not require separate funding, has probably caused more visibility of this program than is warranted. We believe an alternative funding strategy for VE is in order, such as inclusion of VE costs within each project cost exceeding $3 million.

IN-HOUSE VERSUS A-E CONTRACT DESIGN

The finding that costs for in-house design appear lower than design by A-E contractors could lead to a recommendation to keep more work in-house. We believe that the lower in-house P&D ratio, attributed in part to the absence of A-E profit and the cost to administer a Government contract, may be misleading. It could be that in-house projects are less complex than A-E projects which sometimes require specialized skills available only in the private sector. In-house projects are sometimes selected because of the capacity of a district to begin work immediately on high priority customer projects, rather than wait 6 to 8 months to award an A-E contract. The resulting increased productivity and fewer reviews could give a false reading that the in-house team is less costly than the A-E contractor.

Conversely, a certain level of workload must be retained in-house to maintain in-house skills that allow for quick response. The Corps' goal of 25 percent in-house work has been difficult to achieve in past years because of the large construction program. Now that the workload is declining that goal is within reach. It may be appropriate, however, to consider alternatives to a fixed percentage of total program. Each engineering organization should maintain a certain level of in-house effort, regardless of the total construction program size. The limited design skills of USACE architects and engineers will not allow all of them to become proficient on in-house projects, and a selected volume of work should always be contracted to the private sector.

COMPARISON WITH PRIVATE SECTOR

Our findings reveal that USACE costs for planning and design are comparable to those experienced in the private sector. We expect there are variances in P&D efficiency between districts and divisions but the sample size does not permit valid internal comparisons. Additional data will be needed to make that comparison.

CHAPTER 5

RECOMMENDATIONS

PLANNING AND DESIGN COST MODEL

We recommend that a new P&D model be incorporated into the planning and budgeting decision process to estimate more accurately the funding requirements for the design portion of the P&D account. This model should be incorporated into the Corps of Engineers Resource and Military Manpower System (CERAMMS) model to ensure that manpower estimates for construction and design, which are based upon projected construction programs, are fully compatible with the P&D requirements. We further recommend that DoD be made aware of the effect of continuing to use the current 7.5 percent/2-year spread method with the pitfalls possible in the out years. DoD also should be advised of the merits of the comprehensive factors and relationships of this new model and should encourage each Service to incorporate the same principles into their P&D estimating procedures to allow a unified approach to budget and appropriation decision makers.

A proposed model has been developed and demonstrated as part of this report. The model is based upon factors derived from the latest 3 years of data (1987 through 1989) available in the AMPRS, because that period most closely matches the current trend of P&D requirements.

Key Model Features

- *Spreading factors* – The execution rate of MILCON P&D spans approximately 4 years, rather than the 2 years current procedures are based on. The new spreading factors permit variations within each appropriation so quarterly profiles have also been included to help predict quarterly allocation requirements within each fiscal year.

- *Separate customer rates* – Variations between customers are significant and separate rates for each traditional Corps customer have been developed within the model. The rate for Military Construction, Air Force, for example, is higher than Military Construction, Army because of the historical mix of projects and more costly Air Force P&D requirements.

- *Construction program estimates* – Projected levels of construction programs by future fiscal year are the primary inputs that will determine P&D requirements. Major commands or others who plan outyear construction requirements can provide project-level detail, including project size, to refine P&D estimates. The mix of project sizes has a significant effect on the total P&D requirement. Projects less than $1 million require more than double the P&D funds per construction dollar than do projects over $10 million.

- *Mortality factors* – The rate at which projects have historically survived the programming, budgeting, and congressional review processes has also been factored into the P&D model. To the degree that projects can be saved through better planning and stronger justifications during the reviews, the mortality factors can be adjusted.

Automated Scenario Analyses

The model is based on LOTUS software and can be run on a personal computer in conjunction with the CERAMMS model. By varying the input assumptions, i.e., outyear construction programs and in-house design estimates, the user is able to quickly determine P&D requirements for a wide range of alternatives. The basic CERAMMS model will at the same time estimate the manpower and associated USACE supervision and administration (S&A) funds required for each outyear forecast.

DIVISION AND DISTRICT COMPOSITE P&D TARGETS

We recommend that the model be used to develop individual division and district targets for managing their P&D programs. The mix of projects, programs, and customers unique to each engineering organization can be provided as inputs to develop funding levels for management control. The model will also assist in developing realistic division and district funding allocations using a dollar-weighted average approach.

DESIGN BREAKAGE AND LOST DESIGN

An aggressive program is needed to control design breakage and lost design. Reductions in both categories will improve the management of scarce P&D funds. We recommend that controls be instituted within the MILCON programming and budgeting processes to "lock in" programs at certain points to minimize the turbulence of adding or deleting programs. Customers who cause projects to drop or

generate significant changes should have to reimburse USACE for the scrapped designs with their own funds, rather than continuing to tap the P&D account.

PROJECT SIZE DIFFERENTIAL

We recommend that reasons for the significant differences between the percentage of design costs for large and small projects be thoroughly investigated to determine the cause. If, for example, there are standard design services being provided for each project, perhaps some could be trimmed back for the smaller projects without affecting design quality.

P&D MANAGEMENT RESPONSIBILITY

At both the headquarters and field levels, responsibility for managing P&D must firmly reside with key individuals. We recommend that project managers be held responsible for the P&D funds for each project and document the reasons that projects fall outside these acceptable fund control limits. They should also initiate corrective action and document lessons learned to avoid future problems. Responsibility for the P&D functions within the engineering and project management organizations must be clearly defined and understood. Division chiefs share common responsibility for overall management of P&D manpower and funds.

UPDATE P&D RELATIONSHIPS

The model LMI developed to assist in determining P&D requirements is based on information derived from recent P&D execution history. As improvements are made in management of P&D, the basis for the factors and relationships within the model will change. We recommend that a comprehensive review of execution data be made every 3 years to test the model parameters and make adjustments as necessary.

APPENDIX A

DETAILED PLANNING AND DESIGN DATA

Logistics Management Institute collected and analyzed a vast amount of information on planning and design (P&D) costs for U.S. Army Corps of Engineers (USACE) military construction programs. We have added this appendix for the benefit of those readers who want to see more detailed P&D ratios and underlying data.

In particular, we have developed Tables A-1 through A-4, each with the same structure, in which projects are grouped by these criteria:

- Customer/fund type
- Program year (PY)
- Construction contract (CC) amount
- Design agent.

The following statistics were then calculated for each project group:

- Number of projects
- Average P&D costs
- Average CC amount
- The ratio of average P&D costs to average CC amount.

Tables A-1 and A-2 cover the entire PY85 through PY89 analysis period, while Tables A-3 and A-4 cover the PY87 through PY89 period upon which P&D model factors were based. Tables A-1 and A-3 contain statistics for all projects and for groupings based on one classification variable (one-way breakdowns), while Tables A-2 and A-4 contain statistics for groupings based on two classification variables (two-way breakdowns). Results for groupings based on program year are not included in Tables A-3 and A-4, since such results would duplicate information presented in Tables A-1 and A-2.

TABLE A-1

USACE PLANNING AND DESIGN COSTS (PY85-PY89):
TOTALS AND ONE-WAY BREAKDOWNS

Fund Type	Program Year	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
(ALL)	(ALL)	(ALL)	(ALL)	5222	187	2270	0.083
MCA				842	402	4840	0.083
MCAR				94	235	2681	0.088
MCAF				1062	351	3477	0.101
MCO				555	182	2510	0.072
OMA				1500	37	405	0.092
OMAF				344	39	604	0.064
FHA				588	62	1747	0.035
FHAF				16	81	2296	0.035
PBS				171	161	2006	0.080
FMS				27	252	4171	0.060
HNS				4	298	7187	0.042
DERP				19	163	4036	0.040
	1985			819	265	3630	0.073
	1986			1131	208	2559	0.081
	1987			1413	138	1722	0.080
	1988			1093	172	1943	0.089
	1989			766	187	1865	0.100
		$0M-$1M		3037	47	314	0.149
		$1M-$5M		1555	233	2327	0.100
		$5M-$10M		388	520	6954	0.075
		> $10M		242	1128	18938	0.060
			A-E Firm	3617	211	2471	0.085
			In-house	1605	135	1815	0.074

Note: Fund Type codes are explained in Tables D-3 and D-4, except for HNS (Host Nation Support) and DERP (Defense Environmental Restoration Program).

TABLE A-2

USACE PLANNING AND DESIGN COSTS (PY85-PY89):
TWO-WAY BREAKDOWNS

Fund Type	Program Year	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
MCA	1985			193	421	5979	0.070
MCA	1986			254	397	4794	0.083
MCA	1987			187	342	3734	0.092
MCA	1988			128	441	4336	0.102
MCA	1989			80	446	5629	0.079
MCAR	1985			18	196	2125	0.092
MCAR	1986			15	212	3193	0.066
MCAR	1987			21	241	2925	0.082
MCAR	1988			20	267	2940	0.091
MCAR	1989			20	251	2283	0.110
MCAF	1985			214	397	4433	0.090
MCAF	1986			225	358	3730	0.096
MCAF	1987			241	261	2641	0.099
MCAF	1988			211	373	3514	0.106
MCAF	1989			171	382	3078	0.124
MCO	1985			83	285	5009	0.057
MCO	1986			125	176	1920	0.091
MCO	1987			127	192	2413	0.080
MCO	1988			145	121	2122	0.057
MCO	1989			75	178	1642	0.108
OMA	1985			197	50	609	0.081
OMA	1986			292	34	455	0.076
OMA	1987			486	34	378	0.090
OMA	1988			317	33	265	0.125
OMA	1989			208	42	415	0.102
OMAF	1985			27	55	1594	0.034
OMAF	1986			72	49	638	0.077
OMAF	1987			115	36	642	0.057
OMAF	1988			79	30	396	0.077
OMAF	1989			51	34	265	0.127
FHA	1985			45	112	2963	0.038
FHA	1986			90	81	2692	0.030
FHA	1987			183	49	1693	0.029
FHA	1988			145	60	1557	0.038
FHA	1989			125	50	930	0.053
FHAF	1985			6	70	2661	0.026
FHAF	1986			4	86	3848	0.022
FHAF	1987			1	39	84	0.467
FHAF	1988			1	33	2570	0.013
FHAF	1989			4	112	680	0.165

TABLE A-2

USACE PLANNING AND DESIGN COSTS (PY85-PY89):
TWO-WAY BREAKDOWNS (CONTINUED)

Fund Type	Program Year	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
PBS	1985			25	215	2923	0.074
PBS	1986			38	116	2069	0.056
PBS	1987			38	186	1925	0.097
PBS	1988			42	96	1527	0.063
PBS	1989			28	235	1930	0.122
FMS	1985			8	78	1852	0.042
FMS	1986			9	159	3180	0.050
FMS	1987			6	83	3570	0.023
FMS	1988			3	1399	15578	0.090
FMS	1989			1	51	1041	0.049
HNS	1987			3	385	7706	0.050
HNS	1988			1	39	5627	0.007
DERP	1985			3	401	5271	0.076
DERP	1986			7	167	817	0.204
DERP	1987			5	101	9131	0.011
DERP	1988			1	27	115	0.239
DERP	1989			3	62	3128	0.020
MCA		$0M-$1M		206	85	561	0.152
MCA		$1M-$5M		383	258	2460	0.105
MCA		$5M-$10M		144	562	6957	0.081
MCA		> $10M		109	1293	18490	0.070
MCAR		$0M-$1M		9	51	437	0.116
MCAR		$1M-$5M		73	235	2346	0.100
MCAR		$5M-$10M		11	354	6055	0.059
MCAR		> $10M		1	601	10213	0.059
MCAF		$0M-$1M		293	117	584	0.201
MCAF		$1M-$5M		547	302	2440	0.124
MCAF		$5M-$10M		147	573	7010	0.082
MCAF		> $10M		75	1182	15413	0.077
MCO		$0M-$1M		298	69	396	0.175
MCO		$1M-$5M		202	195	2274	0.086
MCO		$5M-$10M		34	492	7183	0.069
MCO		> $10M		21	1146	27225	0.042
OMA		$0M-$1M		1347	31	238	0.129
OMA		$1M-$5M		147	91	1723	0.053
OMA		$5M-$10M		6	143	5563	0.026
OMAF		$0M-$1M		302	25	239	0.103
OMAF		$1M-$5M		36	105	2316	0.045
OMAF		$5M-$10M		5	352	8379	0.042
OMAF		> $10M		1	375	10252	0.037

TABLE A-2

USACE PLANNING AND DESIGN COSTS (PY85-PY89):
TWO-WAY BREAKDOWNS (CONTINUED)

Fund Type	Program Year	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
FHA		$0M-$1M		448	27	234	0.116
FHA		$1M-$5M		92	131	2318	0.057
FHA		$5M-$10M		28	244	6692	0.037
FHA		> $10M		20	255	26104	0.010
FHAF		$0M-$1M		9	32	279	0.115
FHAF		$1M-$5M		5	140	2746	0.051
FHAF		$5M-$10M		1	104	9917	0.010
FHAF		> $10M		1	195	10578	0.018
PBS		$0M-$1M		108	61	344	0.176
PBS		$1M-$5M		47	160	1929	0.083
PBS		$5M-$10M		8	609	6631	0.092
PBS		> $10M		8	1064	20270	0.052
FMS		$0M-$1M		4	74	421	0.175
FMS		$1M-$5M		19	141	2381	0.059
FMS		> $10M		4	960	16424	0.058
HNS		$1M-$5M		2	174	4231	0.041
HNS		$5M-$10M		1	39	5627	0.007
HNS		> $10M		1	806	14658	0.055
DERP		$0M-$1M		13	83	444	0.187
DERP		$1M-$5M		2	288	1396	0.206
DERP		$5M-$10M		3	449	7948	0.056
DERP		> $10M		1	85	44276	0.002
MCA			A-E Firm	604	429	5274	0.081
MCA			In-house	238	332	3738	0.089
MCAR			A-E Firm	68	243	2559	0.095
MCAR			In-house	26	217	3000	0.072
MCAF			A-E Firm	750	382	3698	0.103
MCAF			In-house	312	277	2945	0.094
MCO			A-E Firm	443	201	2727	0.074
MCO			In-house	112	107	1651	0.065
OMA			A-E Firm	1029	43	474	0.091
OMA			In-house	471	24	252	0.094
OMAF			A-E Firm	235	43	478	0.090
OMAF			In-house	109	30	874	0.034
FHA			A-E Firm	312	95	2097	0.045
FHA			In-house	276	23	1352	0.017
FHAF			A-E Firm	7	109	1155	0.094
FHAF			In-house	9	59	3183	0.018
PBS			A-E Firm	145	139	1740	0.080
PBS			In-house	26	278	3491	0.080
FMS			A-E Firm	5	557	6229	0.089
FMS			In-house	22	183	3704	0.049
HNS			A-E Firm	4	298	7187	0.042
DERP			A-E Firm	15	156	1527	0.102
DERP			In-house	4	189	13444	0.014

TABLE A-2

USACE PLANNING AND DESIGN COSTS (PY85-PY89):
TWO-WAY BREAKDOWNS (CONTINUED)

Fund Type	Program Year	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
	1985	$0M-$1M		337	66	384	0.171
	1985	$1M-$5M		319	229	2415	0.095
	1985	$5M-$10M		100	478	7154	0.067
	1985	> $10M		63	1179	21549	0.055
	1986	$0M-$1M		599	53	378	0.139
	1986	$1M-$5M		366	232	2397	0.097
	1986	$5M-$10M		108	507	6938	0.073
	1986	> $10M		58	1095	17952	0.061
	1987	$0M-$1M		934	40	285	0.141
	1987	$1M-$5M		370	193	2248	0.086
	1987	$5M-$10M		60	505	7154	0.071
	1987	> $10M		49	1145	18481	0.062
	1988	$0M-$1M		701	42	276	0.151
	1988	$1M-$5M		274	251	2276	0.110
	1988	$5M-$10M		75	538	6623	0.081
	1988	> $10M		43	1154	18815	0.061
	1989	$0M-$1M		466	47	294	0.160
	1989	$1M-$5M		226	281	2278	0.123
	1989	$5M-$10M		45	630	6832	0.092
	1989	> $10M		29	1021	16196	0.063
	1985		A-E Firm	632	290	3931	0.074
	1985		In-house	187	184	2611	0.070
	1986		A-E Firm	875	212	2527	0.084
	1986		In-house	256	194	2668	0.073
	1987		A-E Firm	915	159	1795	0.088
	1987		In-house	498	101	1589	0.064
	1988		A-E Firm	681	201	2218	0.091
	1988		In-house	412	123	1488	0.083
	1989		A-E Firm	514	218	2122	0.103
	1989		In-house	252	125	1342	0.093
		$0M-$1M	A-E Firm	1983	55	348	0.159
		$0M-$1M	In-house	1054	31	249	0.123
		$1M-$5M	A-E Firm	1152	237	2331	0.102
		$1M-$5M	In-house	403	219	2315	0.095
		$5M-$10M	A-E Firm	295	531	6891	0.077
		$5M-$10M	In-house	93	482	7155	0.067
		> $10M	A-E Firm	187	1187	18882	0.063
		> $10M	In-house	55	930	19130	0.049

TABLE A-3

USACE PLANNING AND DESIGN COSTS (PY87-PY89):
TOTALS AND ONE-WAY BREAKDOWNS

Fund Type	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
(ALL)	(ALL)	(ALL)	3272	161	1829	0.088
MCA			395	395	4313	0.092
MCAR			61	253	2719	0.093
MCAF			623	332	3057	0.109
MCO			347	159	2125	0.075
OMA			1011	35	350	0.101
OMAF			245	34	484	0.070
FHA			453	53	1439	0.037
FHAF			6	87	896	0.097
PBS			108	164	1771	0.092
FMS			10	474	6919	0.069
HNS			4	298	7187	0.042
DERP			9	80	6128	0.013
	$0M-$1M		2101	42	284	0.148
	$1M-$5M		870	234	2265	0.103
	$5M-$10M		180	550	6853	0.080
	> $10M		121	1118	18052	0.062
		A-E Firm	2110	187	2011	0.093
		In-house	1162	114	1499	0.076

TABLE A-4

USACE PLANNING AND DESIGN COSTS (PY87-PY89):
TWO-WAY BREAKDOWNS

Fund Type	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
MCA	$0M-$1M		110	81	526	0.154
MCA	$1M-$5M		169	263	2392	0.110
MCA	$5M-$10M		67	599	6873	0.087
MCA	> $10M		49	1279	15937	0.080
MCAR	$0M-$1M		5	36	282	0.126
MCAR	$1M-$5M		49	244	2353	0.104
MCAR	$5M-$10M		6	450	6494	0.069
MCAR	> $10M		1	601	10213	0.059
MCAF	$0M-$1M		180	126	605	0.208
MCAF	$1M-$5M		341	296	2367	0.125
MCAF	$5M-$10M		65	612	6923	0.088
MCAF	> $10M		37	1180	14549	0.081
MCO	$0M-$1M		206	49	362	0.136
MCO	$1M-$5M		117	196	2186	0.090
MCO	$5M-$10M		14	573	7141	0.080
MCO	> $10M		10	1419	30707	0.046
OMA	$0M-$1M		926	29	218	0.133
OMA	$1M-$5M		83	102	1687	0.060
OMA	$5M-$10M		2	304	6233	0.049
OMAF	$0M-$1M		221	25	247	0.103
OMAF	$1M-$5M		22	98	2084	0.047
OMAF	$5M-$10M		1	159	7966	0.020
OMAF	> $10M		1	375	10252	0.037
FHA	$0M-$1M		367	23	188	0.122
FHA	$1M-$5M		55	137	2336	0.059
FHA	$5M-$10M		17	233	6484	0.036
FHA	> $10M		14	280	24568	0.011
FHAF	$0M-$1M		4	31	192	0.162
FHAF	$1M-$5M		2	199	2303	0.086
PBS	$0M-$1M		74	69	345	0.201
PBS	$1M-$5M		24	160	1888	0.085
PBS	$5M-$10M		6	583	6589	0.089
PBS	> $10M		4	1305	20234	0.064
FMS	$0M-$1M		1	163	416	0.391
FMS	$1M-$5M		6	128	2515	0.051
FMS	> $10M		3	1271	17895	0.071
HNS	$1M-$5M		2	174	4231	0.041
HNS	$5M-$10M		1	39	5627	0.007
HNS	> $10M		1	806	14658	0.055
DERP	$0M-$1M		7	65	377	0.173
DERP	$5M-$10M		1	174	8233	0.021
DERP	> $10M		1	85	44276	0.002

TABLE A-4

USACE PLANNING AND DESIGN COSTS (PY87-PY89):
TWO-WAY BREAKDOWNS (CONTINUED)

Fund Type	CC Amount	Design Agent	Project Count	Average P&D ($K)	Average CC ($K)	Avg. P&D /Avg. CC
MCA		A-E Firm	280	422	4565	0.092
MCA		In-house	115	332	3698	0.090
MCAR		A-E Firm	46	256	2477	0.104
MCAR		In-house	15	242	3462	0.070
MCAF		A-E Firm	413	361	3189	0.113
MCAF		In-house	210	276	2798	0.099
MCO		A-E Firm	266	180	2363	0.076
MCO		In-house	81	90	1344	0.067
OMA		A-E Firm	634	43	424	0.101
OMA		In-house	377	23	226	0.103
OMAF		A-E Firm	166	39	406	0.096
OMAF		In-house	79	23	648	0.035
FHA		A-E Firm	199	94	2046	0.046
FHA		In-house	254	20	963	0.021
FHAF		A-E Firm	3	148	903	0.164
FHAF		In-house	3	26	889	0.030
PBS		A-E Firm	92	124	1185	0.105
PBS		In-house	16	390	5142	0.076
FMS		A-E Firm	1	1847	19468	0.095
FMS		In-house	9	322	5525	0.058
HNS		A-E Firm	4	298	7187	0.042
DERP		A-E Firm	6	20	394	0.050
DERP		In-house	3	200	17595	0.011
	$0M-$1M	A-E Firm	1267	52	329	0.158
	$0M-$1M	In-house	834	27	216	0.126
	$1M-$5M	A-E Firm	620	242	2274	0.106
	$1M-$5M	In-house	250	215	2243	0.096
	$5M-$10M	A-E Firm	136	559	6696	0.083
	$5M-$10M	In-house	44	522	7335	0.071
	> $10M	A-E Firm	87	1177	17311	0.068
	> $10M	In-house	34	968	19947	0.049

APPENDIX B

ANALYSIS OF DIFFERENCES BETWEEN ARMY AND AIR FORCE COSTS

As documented in the text and in Appendix A, the U.S. Army Corps of Engineers (USACE) planning and design (P&D) costs were different for Army and Air Force projects. Air Force P&D cost ratios were higher than Army P&D cost ratios for military construction projects, but lower for operations and maintenance projects, during the 5-year analysis period (there were too few Air Force projects to draw any meaningful conclusions about family housing).

We investigated a number of possible explanations for these results. The most significant factor was project size. Table B-1 shows that higher P&D cost ratios were associated with smaller average construction contract (CC) amounts for both appropriations. The difference between Army (including Army Reserve) and Air Force P&D rates for military construction projects would have been 1.1 to 1.2 percent instead of 1.8 percent if the project size mix had been the same for both Services. Similarly, the difference for operations and maintenance projects would have been 0.9 to 1.7 percent instead of 2.8 percent if the project size mix had been the same for both Services.

A second contributing factor was the design costs associated with lost design. In particular, we found that average lost design costs were a higher proportion of total design costs for Air Force projects than for Army projects. This accounted for 0.2 to 0.3 percent of the difference in P&D ratios for military construction (the impact of lost design costs on operations and maintenance P&D ratios was minimal). Although lost design costs appear to be significantly underreported in Automated Management and Progress Reporting System (AMPRS), our findings were supported by additional data obtained from the Corps of Engineers' Management Information System (COEMIS).

Two other factors have probably contributed to higher Air Force P&D ratios, but their effects cannot be measured using our database. One such factor is the Air Force requirement for comprehensive interior design. It should be noted that the

TABLE B-1

ARMY AND AIR FORCE P&D DATA FOR PY85 THROUGH PY89

Customer/fund type	Number of projects	Average CC amount ($ millions)	Average P&D ratio (%)
Military construction, Army[a]	936	4.6	8.3
Military construction, Air Force	1,062	3.5	10.1
Operations and maintenance, Army	1,500	0.4	9.2
Operations and maintenance, Air Force	344	0.6	6.4

Note: PY = program year.

[a] Includes Army Reserve.

Army will also be adopting this requirement in the near future, which may reduce the inter-Service difference. The other unquantifiable factor is the cost added by an additional level of review and coordination by Air Force major commands.

It was also hypothesized that projects associated with new Air Force weapon systems and programs, because of their unique and technology-intensive nature, might have had unusually high P&D cost ratios. However, we analyzed 73 B-1, B-2, and Large Rocket Test Facility projects, representing $200 million in construction contracts, and found that they had the same average project size and P&D ratio as the rest of the Air Force military construction program.

APPENDIX C

ANALYSIS OF NAVY PLANNING AND DESIGN COSTS

To facilitate the development of a DoD-wide planning and design (P&D) cost budgeting strategy, and to see if the same P&D cost patterns and trends were true for Navy work, Logistics Management Institute (LMI) developed a second database using information obtained from the Naval Facilities Engineering Command (NAVFAC). To ensure comparability with the U.S. Army Corps of Engineers (USACE) data, we limited our analysis to program year (PY) 1985 through 1989 projects for which construction contracts (CCs) had been awarded, deleting about 7 percent of those projects because of invalid or missing values. After reducing total CC amounts by the 5.5 percent supervision, inspection, and overhead rate (to match the USACE definition), we adjusted all dollar amounts for inflation.

In general, we found that NAVFAC and USACE had similar P&D costs. As shown in Table C-1, P&D cost ratios for military construction projects performed by NAVFAC ranged by customer from under 8 percent to over 11 percent. NAVFAC had a higher overall P&D cost ratio than USACE for military construction projects – 9.4 percent versus 8.8 percent – but a lower P&D cost ratio for family housing projects – 2.1 percent versus 3.5 percent for USACE. Operations and maintenance projects were not included in the NAVFAC data.

As with USACE, NAVFAC showed a strong inverse relationship between average project sizes and P&D cost ratios. Unlike USACE, however, NAVFAC P&D cost ratios did not significantly increase over time. One explanation for this funding is that the Navy's project size mix has been more stable. Another possible reason is that the composition of Navy military construction projects has shifted toward categories with lower relative P&D costs, offsetting what otherwise might have been an upward trend over time. (The sample size was too small to test this hypothesis.)

Finally, NAVFAC data reveal higher P&D cost ratios and smaller average CC amounts for Air Force military construction projects than for other military construction projects. The same pattern occurred for USACE Air Force military construction projects, as discussed in Appendix B, although the average P&D cost

ratio for all Air Force military construction projects (including National Guard and Reserve) was slightly higher for NAVFAC than for USACE – 10.9 percent versus 10.1 percent.

TABLE C-1

NAVFAC PLANNING AND DESIGN COST DATA (PY85 THROUGH PY89): TOTALS AND ONE-WAY BREAKDOWNS

Project[a] category	Fiscal year	Size of CC ($M)	Project count	Average P&D ($K)	Average CC ($K)	Average P&D/ average CC
Total	Total	Total	1,607	439	4,970	0.088
FHN			80	167	7,965	0.021
MCAF			174	432	3,812	0.113
MCN			1,241	481	5,185	0.093
MCAFNG			27	229	2,933	0.078
MCNR			85	178	2,033	0.088
	1985		341	522	5,641	0.092
	1986		337	499	5,584	0.089
	1987		371	358	4,296	0.083
	1988		274	439	4,740	0.093
	1989		284	377	4,538	0.083
		0 – 1	416	101	575	0.176
		1 – 5	717	275	2,479	0.111
		5 – 10	270	642	7,052	0.091
		Over 10	204	1,440	19,931	0.072

[a] These type codes are explained in Tables A-1, D-3, and D-4.

APPENDIX D

ADJUSTING PRIVATE-SECTOR PLANNING AND DESIGN COSTS

INTRODUCTION

The scope of planning and design of work can vary dramatically. Therefore, when comparing the costs billed to customers for dissimilar projects performed by different firms, it is essential to know what planning and design (P&D) services were provided for the project and to adjust for them. Table D-1 shows the complete list of P&D services that can be provided during any given project. This full service listing includes the American Institute of Architects' (AIA) listing of basic engineering services (from AIA Document B141) supplemented by the Professional Services Management Association's list of additional design services from their annual survey of engineering costs.

Each service shown in Table D-1 adds a different proportion to the total cost of a P&D project. Identifying the relative cost for each service allows a comparison to be made of the total costs between individual projects when the levels of service vary. Unfortunately, neither the private sector nor U.S. Army Corps of Engineers (USACE) currently maintains this level of detail in its cost accounts. However, computing the relative weight each service contributes to the total can be accomplished using a technique called the analytic hierarchical process (AHP) which does not rely on quantitative accounting data. To use this technique, the analyst simply solicits experienced opinions and judgments from a panel of field experts and then quantifies those results using a proven methodology of mathematical algorithms. When the process is complete, AHP assigns relative weights to each of the services – totaling 100 percent – which can then be used to adjust total project costs when the level of services provided is known. Table D-2 shows the listing of all services with their weights determined by the AHP.

DATA SOURCES

The raw data used for comparisons in this study consisted of total P&D costs for various types of construction projects. Data from the private sector was collected from the *Professional Services Management Journal (PSMJ)* database of design costs

TABLE D-1

FULL-SERVICE LISTING OF ENGINEERING SERVICES

	Service
	1.0 Predesign services
	1.1 Facilities programming
	1.2 Site selection/feasibility studies
	1.3 Project cost/budget programming
	1.4 Environmental impact studies
	1.5 Survey of existing facilities
	1.6 Zoning/regulatory approvals
	2.0 Preliminary/concept design
	2.1 Agency approval
	2.2 Written reports on design choices
*	2.3 Initial design submittals
	2.4 Multiple design submittals
	2.5 Energy studies
*	2.6 Budget cost estimates
	3.0 Design development
*	3.1 Preparation of drawings
*	3.2 Development of standard specifications
	4.0 Construction documents
	4.1 Agency approval permits
	4.2 Specifications by owner standards
	4.3 Cost estimates by system component
	4.4 Cost estimates by detail line item
*	4.5 Preparation of bidding documents
	5.0 Bidding/negotiation services
*	5.1 Assistance in evaluating bids and negotiations
	6.0 Construction period services
*	6.1 Periodic site inspections
	6.2 Full-time site representation
	6.3 Purchasing of project materials
*	6.4 Shop drawing review
*	6.5 Change order preparation
*	6.6 Verification of pay estimates
*	6.7 Resolution of contract document conflicts

Note: Items marked with an (*) indicate services that are considered to be part of the basic fee for architectural services per AIA Document B141. Other services listed are considered to be in addition to the basic fee.

TABLE D-2

EXPERT OPINION RESULTS

(Military construction)

Service	Percent of total engineering costs
1.0 Predesign services	**4.5**
1.1 Facilities programming	2.0
1.2 Site selection/feasibility studies	0.9
1.3 Project cost/budget programming	0.5
1.4 Environmental impact studies	0.4
1.5 Survey of existing facilities	0.5
1.6 Zoning/regulatory approvals	0.2
2.0 Preliminary/concept design	**9.8**
2.1 Agency approval	0.3
2.2 Written reports on design choices	1.4
2.3 Initial design submittals	2.6
2.4 Multiple design submittals	4.0
2.5 Energy studies	0.7
2.6 Budget cost estimates	0.8
3.0 Design development	**48.0**
3.1 Preparation of drawings	42.7
3.2 Development of standard specifications	5.3
4.0 Construction documents	**8.5**
4.1 Agency approval permits	0.3
4.2 Specifications by owner standards	1.0
4.3 Cost estimates by system component	1.8
4.4 Cost estimates by detail line item	4.8
4.5 Preparation of bidding documents	0.6
5.0 Bidding/negotiation services	**2.5**
5.1 Assistance in evaluating bids and negotiations	2.5
6.0 Construction period services	**26.6**
6.1 Periodic site inspections	1.4
6.2 Full-time site representation	9.7
6.3 Purchasing of project materials	0.5
6.4 Shop drawing review	7.0
6.5 Change order preparation	4.0
6.6 Verification of pay estimates	0.8
6.7 Resolution of contract document conflicts	3.2
Total	**100.0**

accumulated by type of project. The *PSMJ* database is updated yearly from an annual survey of over 260 participating firms. Data supporting the USACE cost figures were collected from the Corps of Engineers' Management Information System (COEMIS). Only completed USACE construction projects using Military Construction funds were used in the analysis.

COST ADJUSTMENTS

The costs billed to customers cannot legitimately be compared unless each project is adjusted to account for the differences in services provided during the P&D phases of its execution. We make this adjustment by bringing each private-sector project up to the "full service" level. Generally, USACE divisions and districts provide more planning and design services per project than do private-sector organizations because USACE is the sole supplier of engineering services to many DoD agencies. Also, USACE is the contracting officer whenever it provides P&D services and, as such it assumes all responsibility for projects it manages. This is in contrast to the private sector where a project may be divided between engineering services firms. Also, many private-sector firms avoid certain types of services because of the potential liabilities associated with them. However, there are some services (e.g., full-time site representation, verification of pay estimates, and change order preparation) that contribute to private-sector costs that for USACE projects are paid out of supervision and administration (S&A) construction funds and are not captured as USACE P&D costs. Adjustments to the raw data must be made to account for all these differences.

So that the comparisons made in this study are valid, the private-sector raw data were adjusted in two steps. First, the fees presented in the private sector's raw data are adjusted to reflect provision of full service, the basic services shown by asterisks in Table D-1. Second, these full-service fees are again adjusted to reflect those services included in private-sector costs that are paid by S&A funds for USACE projects. The result is an adjusted private-sector P&D fee that can legitimately be compared to a USACE fee. The adjusted private-sector fees are then aggregated by type of project for comparison to USACE fund types. Table D-3 shows how the private-sector project codes are distributed into USACE customer categories. Table D-4 shows the types of funds that support each of the USACE customer categories.

TABLE D-3

MAPPING PRIVATE-SECTOR PROJECT TYPES TO USACE CUSTOMER CATEGORY

(Military engineering)

Family Housing – Army (FHA)
- (12) Apartments/Condos (low rise)
- (13) Single-family housing

Family Housing – Air Force (FHAF)
- (12) Apartments/Condos (low rise)
- (13) Single-family housing

MILCON – Army (MCA)
- (06) Warehouse/distribution centers
- (07) Light industrial
- (10) Motels (low rise)
- (16) Low-rise office buildings
- (24) Dormitory/housing
- (25) Sports/athletic facilities
- (49) Federal office buildings

MILCON – Air Force (MCAF)
- (0) Warehouse/distribution centers
- (07) Light industrial
- (10) Motels (low rise)
- (16) Low-rise office buildings
- (24) Dormitory/housing
- (25) Sports/athletic facilities
- (49) Federal office buildings

MILCON – Army Reserves (MCAR)
- (16) Low-rise office buildings
- (22) Classrooms
- (49) Federal office buildings

MILCON – Other (MCO)
- (04) Medical office
- (06) Warehouse/distribution centers
- (07) Light industrial
- (14) High-rise office buildings
- (15) Mid-rise office buildings
- (20) Retail stores
- (23) Science/research labs
- (26) Churches
- (50) Postal facilities

Operations and Maintenance – Army (OMA)
- (08) Process plants/heavy industrial
- (33) Hazardous waste facilities
- (34) Water/sewer lines
- (36) Roads
- (49) Federal office buildings

Operations and Maintenance – Air Force (OMAF)
- (08) Process plants/heavy industrial
- (33) Hazardous waste facilities
- (34) Water/sewer lines
- (36) Roads
- (49) Federal office buildings

Production Base Support (PBS)
- (08) Process plants/heavy industrial
- (33) Hazardous waste facilities
- (34) Water/sewer lines
- (36) Roads
- (49) Federal office buildings

Note: Two-digit numbers refer to Construction Management Association of America Survey Project Category code.

TABLE D-4

USACE CUSTOMER CATEGORIES

(Military engineering)

Family Housing – Army (FHA)
- (40) Family Housing, New Construction
- (42) Family Housing, Line Item Improvement
- (44) Family Housing, Energy Conservation Investment Program
- (45) Family Housing, Maintenance and Repair

Family Housing – Air Force (FHAF)
- (26) Family Housing, Air Force

MILCON – Army (MCA)
- (10) Military Construction, Army
- (11) Military Construction, Army, unspecified minor construction
- (17) Military Construction, Army National Guard
- (98) Troop Support Agency, Headquarters
- (99) Troop Support Agency, Local

MILCON – Air Force (MCAF)
- (20) Military Construction, Air Force
- (21) Military Construction, Air Force Reserve
- (23) Military Construction, Air Force Minor Construction
- (25) Military Construction, Air National Guard
- (29) Military Construction, Air Force (MIX)

MILCON – Army Reserves (MCAR)
- (12) Military Construction, Army Reserve

MILCON – Other
- (16) Cemetery Funds
- (27) Nonappropriated Funds, Air Force
- (28) Other Air Force Funds
- (31) Other Navy Funds
- (35) Nonappropriated Funds, Navy
- (41) Department of Defense Agencies
- (48) Defense Language Institute
- (50) National Aeronautics and Space Administration
- (51) Department of Defense Dependent Schools
- (53) Defense Communications Electronic Education Testing Act
- (54) Defense Logistics Agency
- (56) Defense Mapping Agency
- (57) Defense Nuclear Agency
- (58) Defense Communications Agency
- (59) Other Nondefense Federal Funds
- (60) Nonappropriated Funds, Army
- (61) Modernization of U.S. Facilities, Federal Republic of Germany
- (62) Alternate Construction, Federal Republic of Germany
- (64) Army/Air Force Exchange, Headquarters
- (65) Army/Air Force Exchange, Local
- (66) U.S. Soldiers' and Airmen's Home
- (69) National Security Agency

Operations and Maintenance – Army (OMA)
- (14) Operations and Maintenance, Army
- (18) Operations and Maintenance, Army Reserve

Operations and Maintenance – Air Force (OMAF)
- (24) Operations and Maintenance, Air Force
- (29) Military Construction, Air Force (MX)

Production Base Support (PBS)
- (15) Production Base Support

Note: Two-digit numbers refer to USACE fund type code.